

Introduction to MPLS Using RouterOS



Irvan Adrian K - Irvan@grahamedia.net.id

Jakarta

Mikrotik User Meeting – Indonesia 2016

About Presenter

- Irvan Adrian Kristiono
- MTCNA (2010), MTCRE (2011), MTCINE (2014)
- Central Network (2011)
 - IT Solution & Training Center
 - <http://www.centralnetwork.net>
- Grahamedia Informasi (2006)
 - Internet Service Provider
 - <http://www.grahamedia.net.id>
- Lokasi kami di Jawa Tengah
Salatiga – Semarang – Demak – Kudus - Purwodadi





Belum tahu tentang MPLS ?

- Mungkin karena harga peralatannya yang tinggi
- Peralatan yang support MPLS masih terbatas
- Hanya Perusahaan kelas Operator Telekomunikasi yang mampu menggunakan MPLS
- Konsep MPLS masih asing di dunia IT Networking
- SDM yang menguasai terbatas



MPLS Available in Mikrotik ROS !!

- Saat ini Fitur MPLS sudah tersedia di Mikrotik RouterOS
- Mulai dari Router RB hAP lite \$22 / Rp. 300.000,- sampai dengan Multicore Router
- Sekarang waktunya Implementasi MPLS



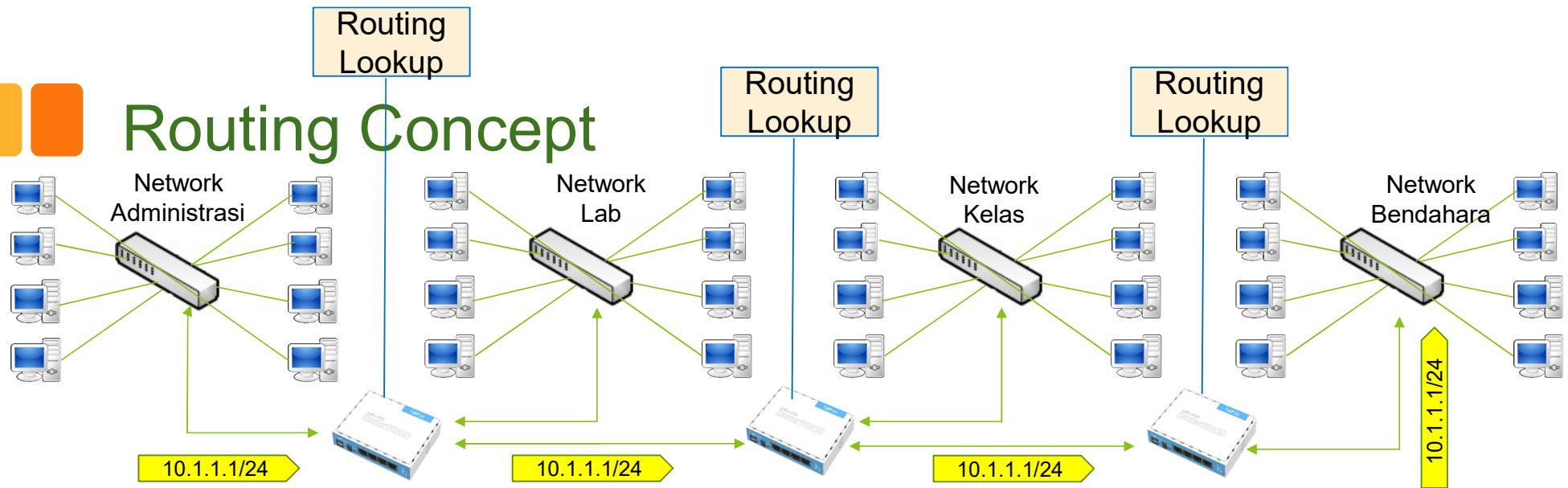


HOW TO NETWORKING

3 metode untuk melakukan koneksi Jaringan :

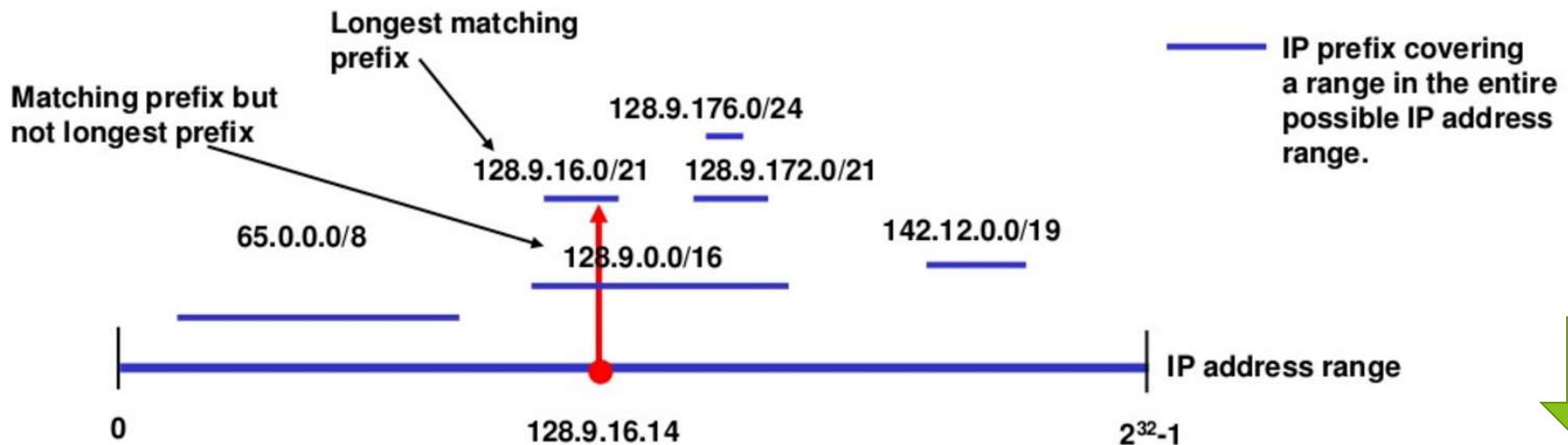
- Bridging
 - STP, RSTP, Mesh
- Routing
 - RIP, OSPF, BGP
- Switching
 - **MPLS**, ATM, Frame Relay

Routing Concept

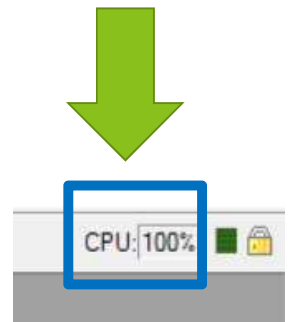


- Dimulai Jaringan kecil LAN dalam 1 Network, kita tidak memerlukan Routing, semua bisa dilakukan menggunakan bridging
- Semakin besar network, karena kebutuhan managent policy, looping, broadcast storm maka dibuat segmentasi network.
- Routing Protocol diperlukan untuk distribusi Informasi Jaringan
- Routing Lookup dilakukan di tiap Hop menggunakan Tabel Routing

Drawbacks Routing Lookup



- Menggunakan CIDR (Classless Inter-Domain Routing) pencarian berdasarkan longest matching prefix”, memakan resource dan proses CPU Router yg cukup besar.
- Router dengan CPU dan Resouce terbatas ini akan jadi permasalahan
- Kebutuhan dan teknologi traffic media semakin besar, tantangannya pada limitasi Proses PPS (Packet per Second) dari CPU.



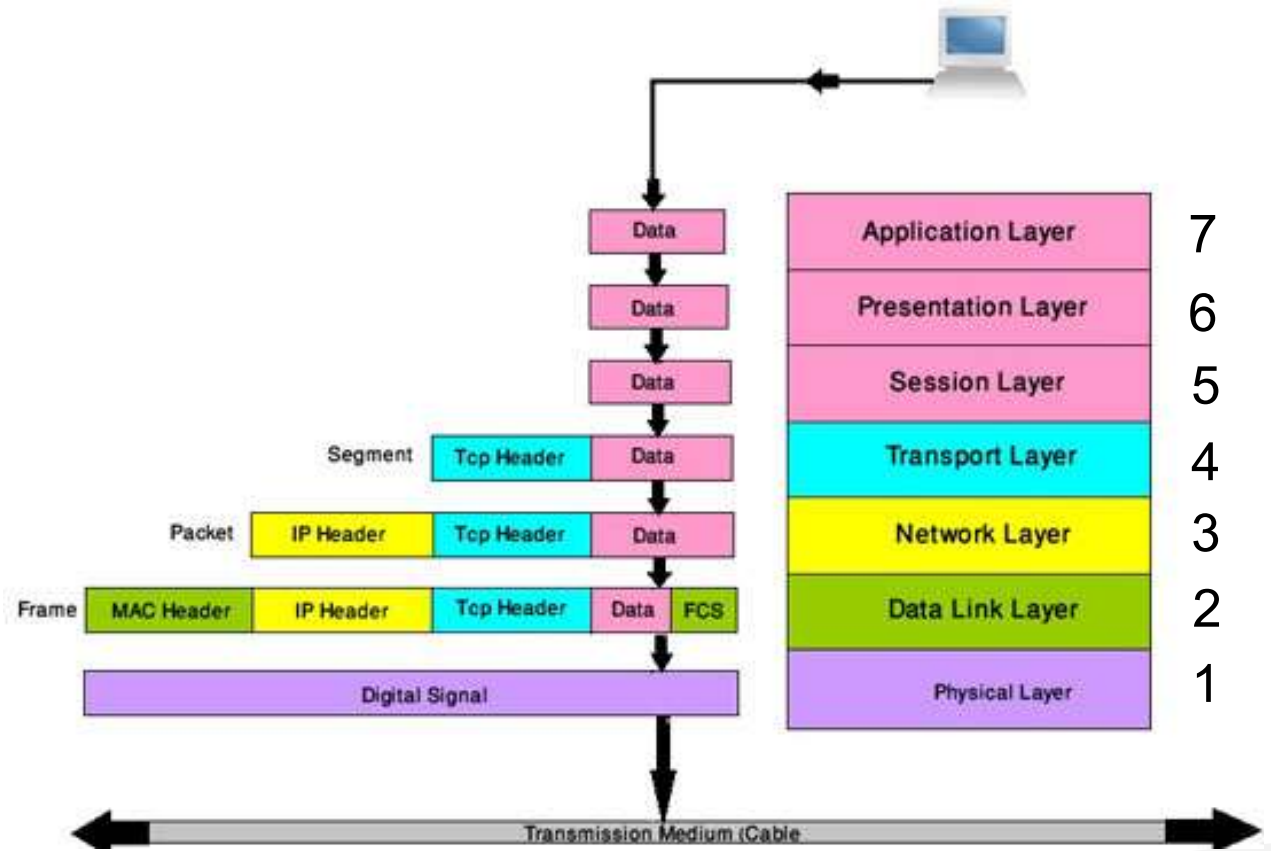
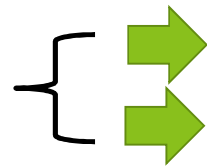


What is MPLS

- MPLS = **M**ulti **P**rotocol **L**abel **S**witching
- MPLS adalah metode pengiriman data yang menggunakan Label yang dilekatkan pada paket
- Dalam network MPLS, forwarding dengan switching label, tanpa memakai IP layer 3 Header
- Routing Lookup yang berat digantikan Label Lookup dengan beban lookup minimal, membuat efisiensi proses dan meningkatkan performa jaringan

LAYER 2.5

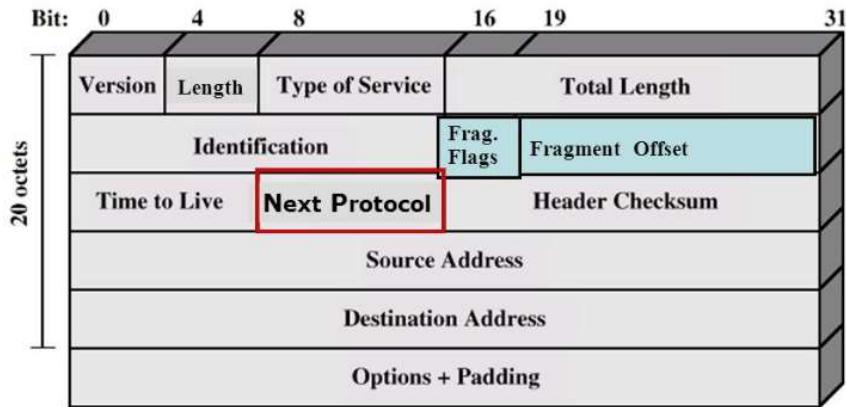
MPLS berada di antara ini



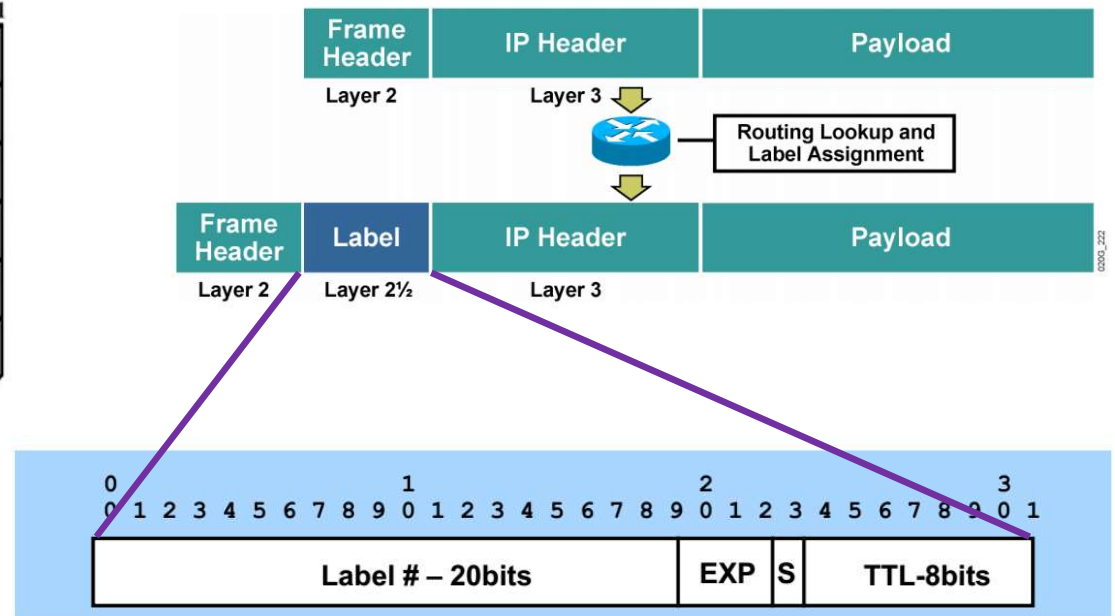
Source : <http://rumyitips.com/wp-content/uploads/2013/08/Most-Common-Interview-Questions-on-OSI-model1.jpg>

MPLS LABELS DAN LABEL ENCAPSULATION

IP Header (20 Bytes)

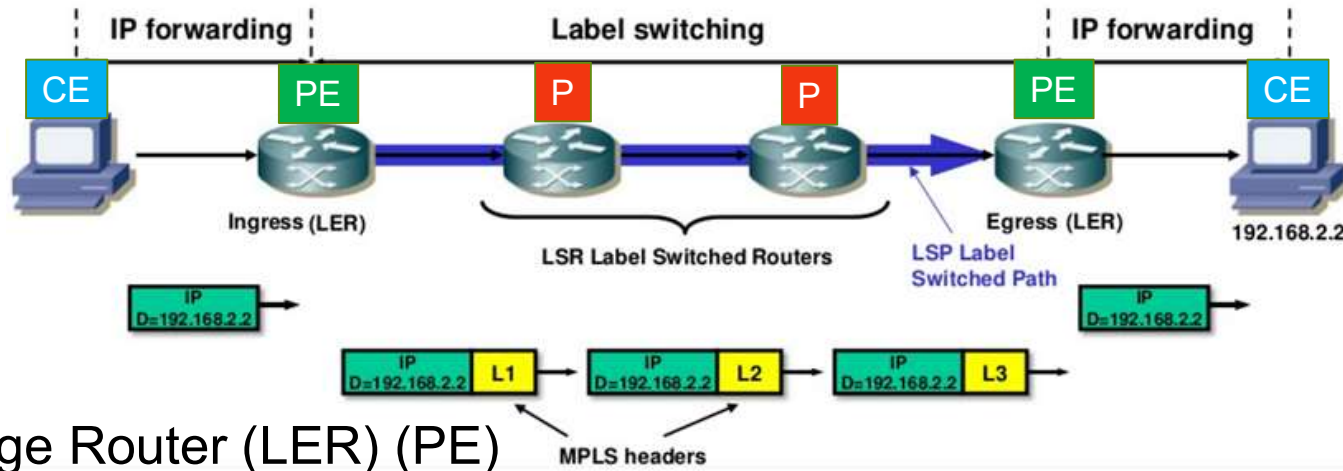


MPLS Header (4 Bytes)



COS/EXP = Class of Service: 3 Bits; S = Bottom of Stack; TTL = Time to Live

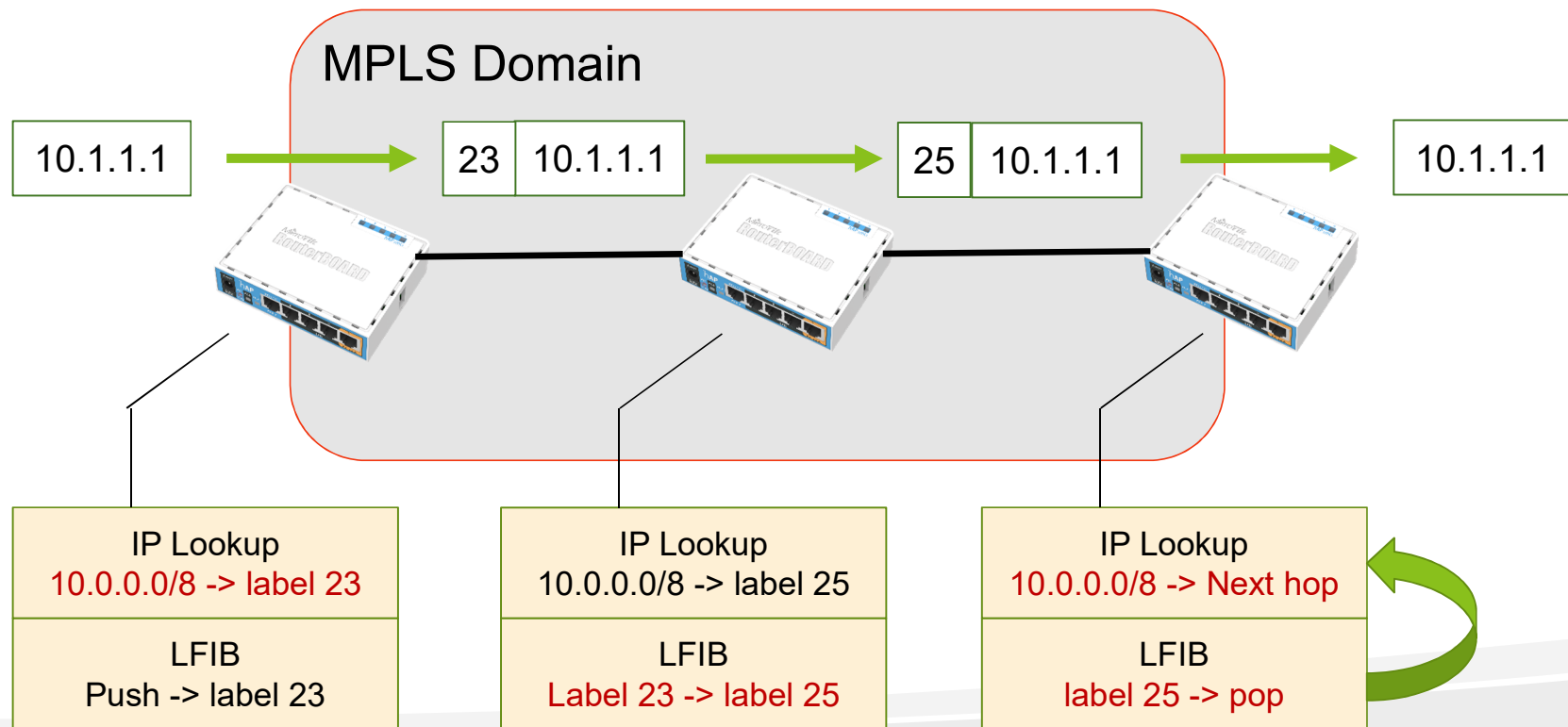
How MPLS Work ?



CE : Customer Edge
 PE : Provider Edge
 P : Provider

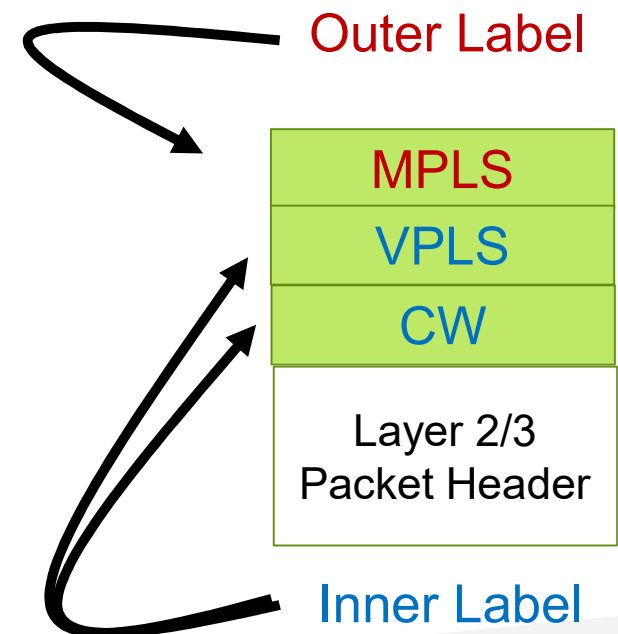
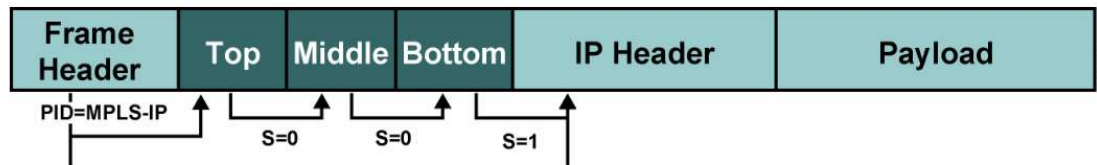
- Label Edge Router (LER) (PE)
 - Perlu adanya **Header Label** pada Paket Data, supaya bisa masuk MPLS Network
 - Label ditambahkan (Push) / dihilangkan (PoP) oleh **Label edge Router (LER)**
- Label Switching Router (LSR) (P)
 - Core Router hanya melakukan switching berdasarkan “Exact Matching” Label Lookup sederhana untuk menukar label untuk hop selanjutnya

MPLS Forwarding Example

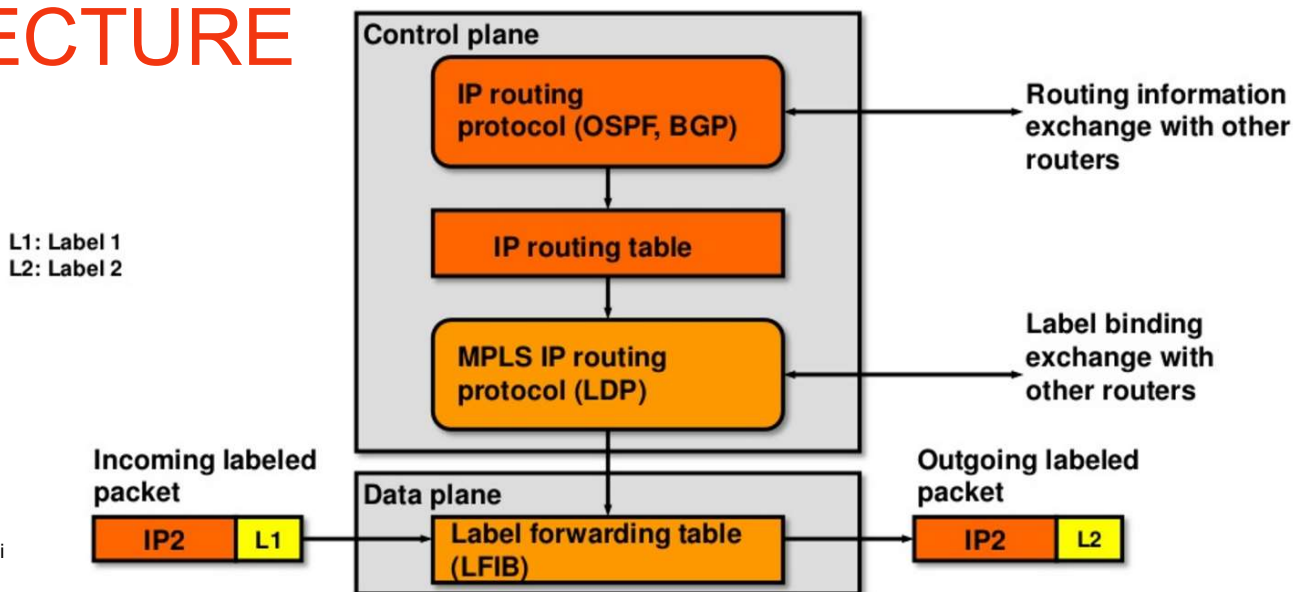


MPLS LABELS STACK (FITUR TAMBAHAN MPLS)

- Dalam satu paket dapat dipasang lebih dari 1 label
- Tiap label memiliki fungsi yang berbeda tujuannya
- Label terluar (Outer Label) selalu digunakan untuk Label pengontrol paket sampai ke LER tujuan
- Sedangkan lainnya untuk Service MPLS lainnya, misalnya VPN dan Traffic Engineering



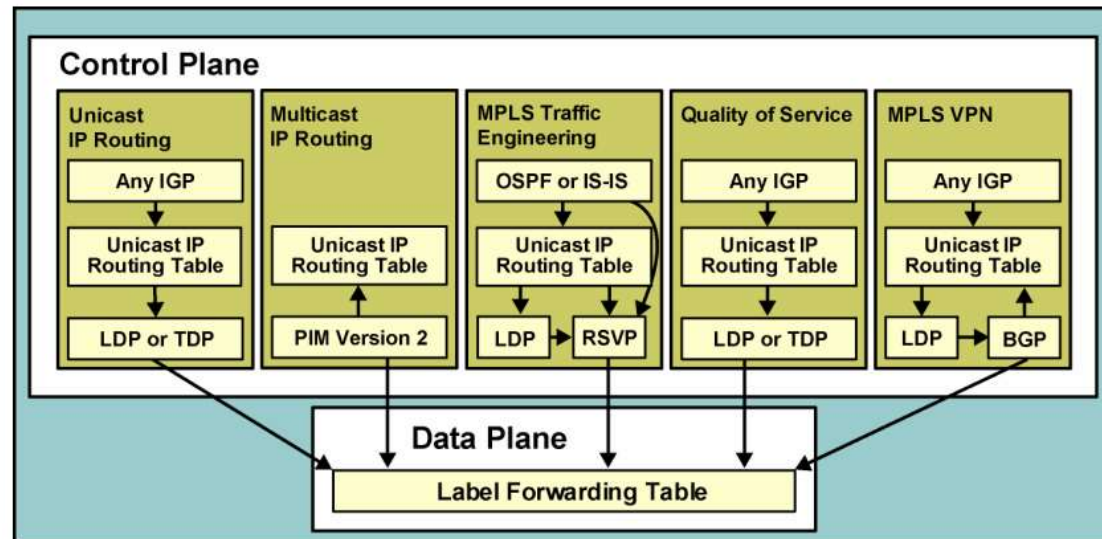
MPLS ARCHITECTURE



Source : Overview of the MPLS backbone transmission technology - Peter R. Egli

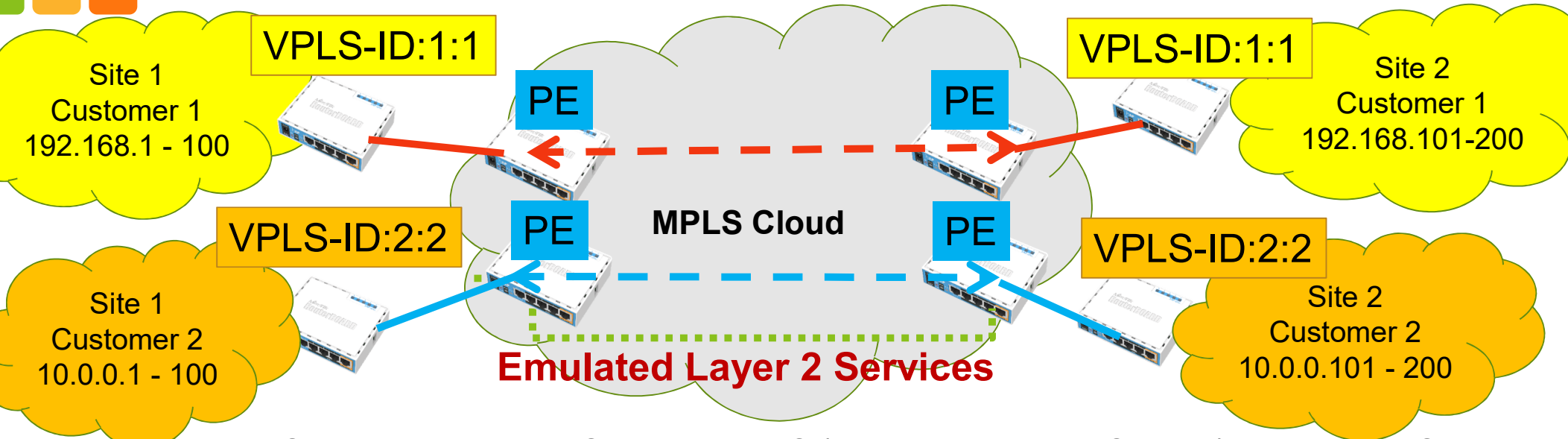
- **Control Plane** : Masih membutuhkan Layer 3 routing protocol untuk menyebarkan informasi routing antara tiap router Network MPLS dan menyebarkan Informasi label pada seluruh router di Network MPLS
Routing Protocol yang bisa digunakan : OSPF, IGRP, EIGRP, IS-IS, RIP
Label Exchange Protocol yang digunakan : LDP, BGP(VPN), RSVP(MPLS-TE)
- **Data Plane** : Proses forwarding sederhana dengan pertukaran Label, Lookup berdasarkan LFIB (Label Forwarding Information Base)

FITUR TAMBAHAN MPLS



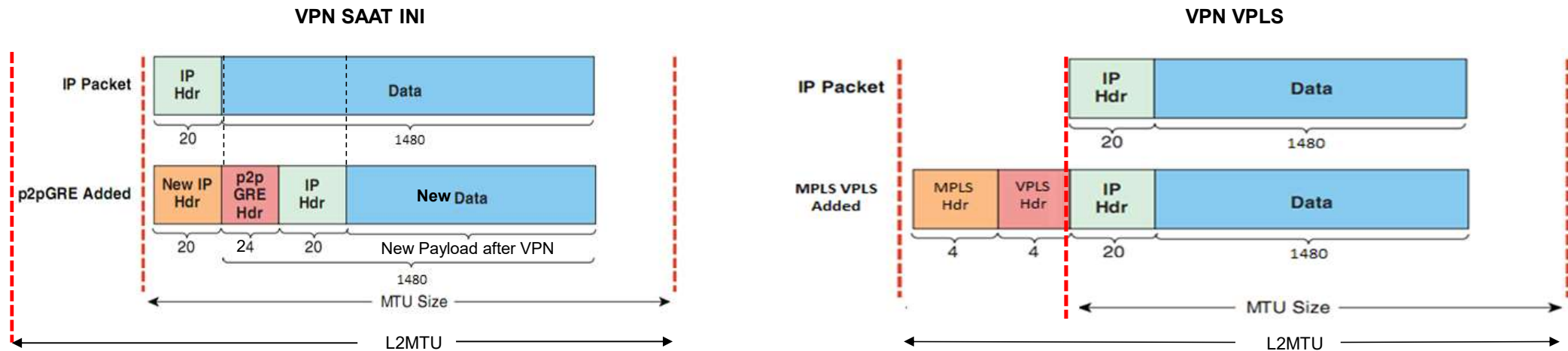
- VPN Layer 2
 - Layer 2 VPN – Tunnel EoMPLS (VPLS)
 - Layer 2 VPN – Multi Site (VPLS)
- VPN Layer 3
 - Layer 3 VPN Multi Site Multi Service (VPNv4)
- Traffic Engineering
 - Bandwidth Optimization (RSVP)
 - Redundant dan Fail Over (RSVP)
- Quality of Service

MPLS L2VPN – Virtual Private LAN Service



- Service L2VPN MPLS disebut VPLS (Virtual Private Lan Service) atau EoMPLS
- Bertujuan membuat Private Tunnel menghubungkan Layer 2 antara 2 site
- VPLS memiliki kemampuan :
 - MAC Learning
 - Flooding
 - Forwarding

MPLS L2VPN : WITHOUT DRAWBACKS L2 PAYLOAD

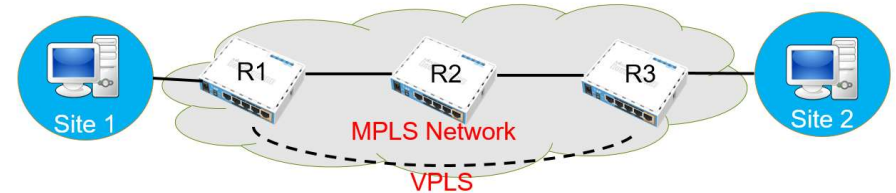
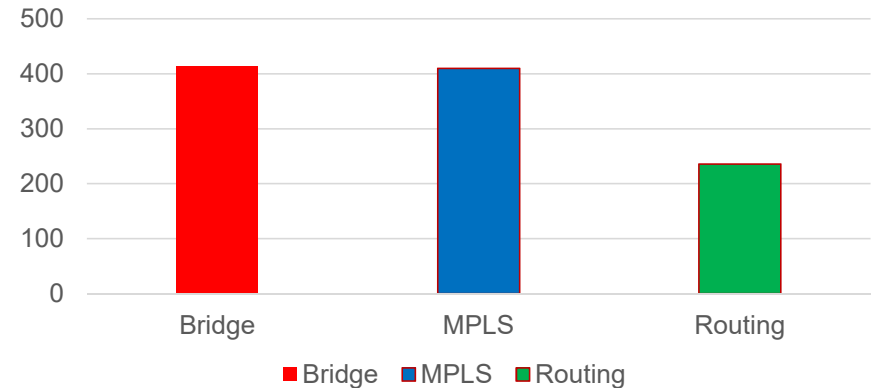


- Big Overhead EoIP (Ethernet + GRE + IP) ~ 40 Bytes
- VPN saat ini menggunakan header yang termasuk dalam L2 Data, dengan tambahan header VPN saat ini harus penyesuaian MTU Data agar dapat masuk tanpa terfragment
- VPLS VPN menggunakan space L2MTU untuk Header MPLS dan VPLS, header lebih kecil dan tidak mengurangi L2 Data
- Benefit : Effisiensi Low Overhead dan Resource

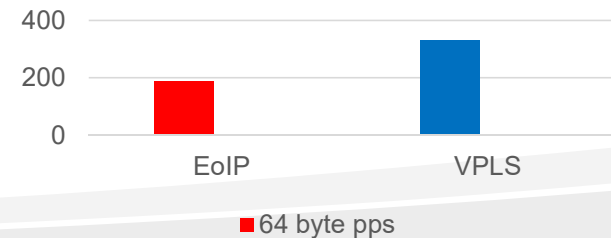
MPLS Performance

- Kecepatan Forwarding MPLS Switching Hampir 2 kali lebih cepat dari IP Routing, Hampir sama kecepatan Layer 2 Bridging
- Tunnel VPLS lebih cepat 60% dari Tunnel EoIP

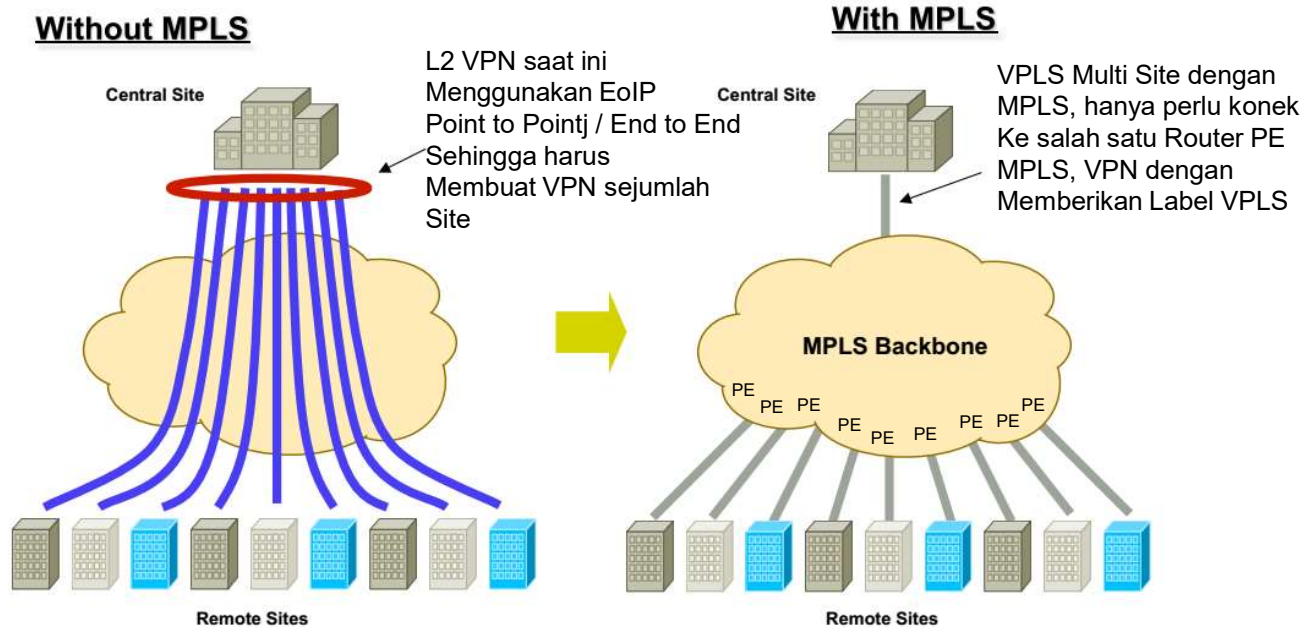
MPLS Performance



EoIP vs MPLS

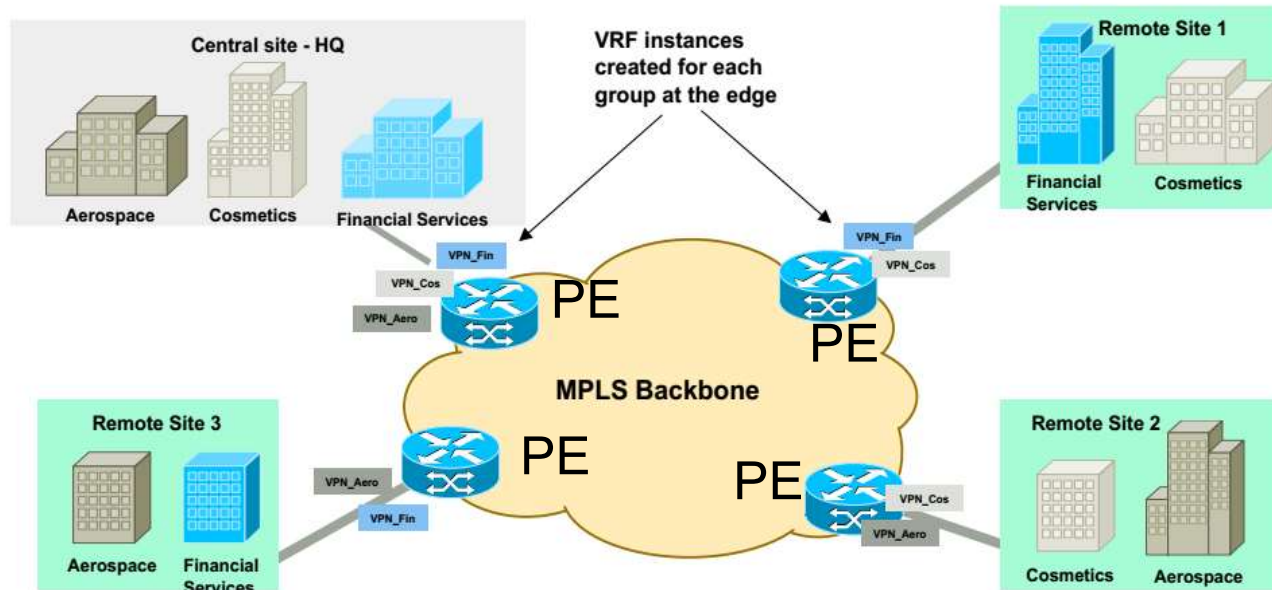


MPLS L2 VPN - MULTI SITE – MESH VPN



- Memungkinkan untuk membuat Mesh L2VPN / Layer 2 VPN Multi Site
- Skalabilitas lebih mudah diexpand, konek VPN tiap site ke PE terdekat
- Menggunakan iBGP VPLS untuk interkoneksi antar PE

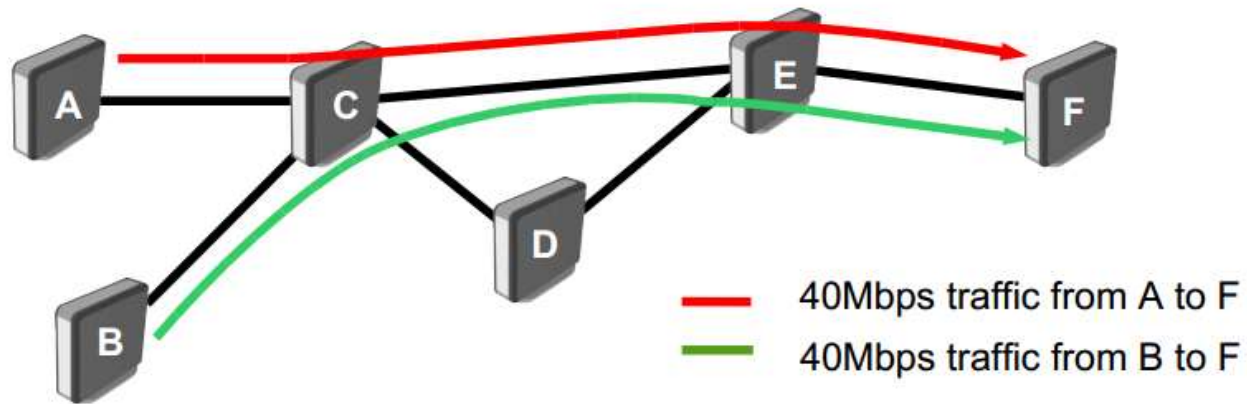
MPLS L3 VPN - MULTI SERVICE MULTI SITE



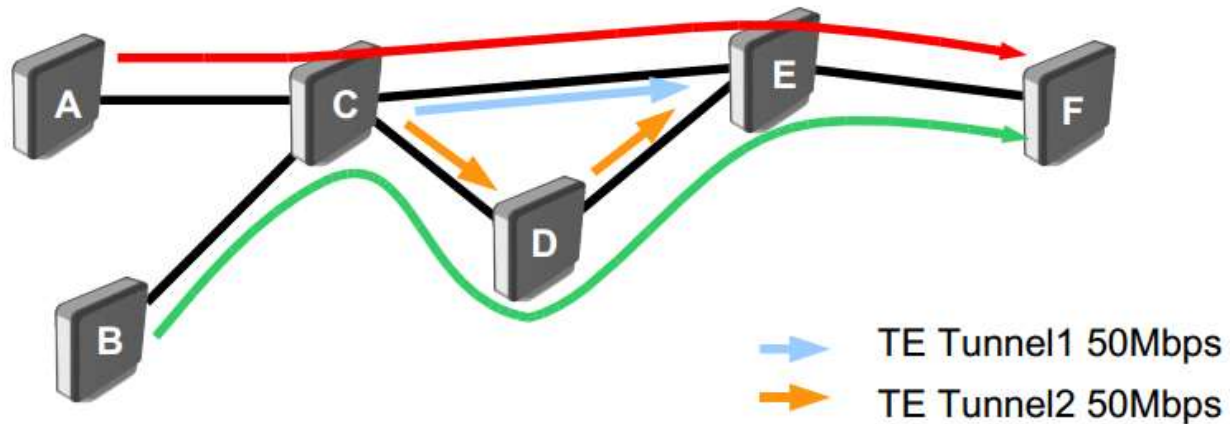
Source : <http://www.sanog.org/resources/sanog17/sanog17-mpls-intro-santanu.pdf>

- iBGP VPNv4 route antar PE Router
- Menggunakan VRF (Virtual Routing Forwarding) untuk memisahkan routing dan forwarding tiap customer
- RD (Router Distinguisher) 8 Byte + VPN Prefix : VPNv4 Address

TRAFFIC ENGINEERING – BANDWIDTH OPTIMIZATION

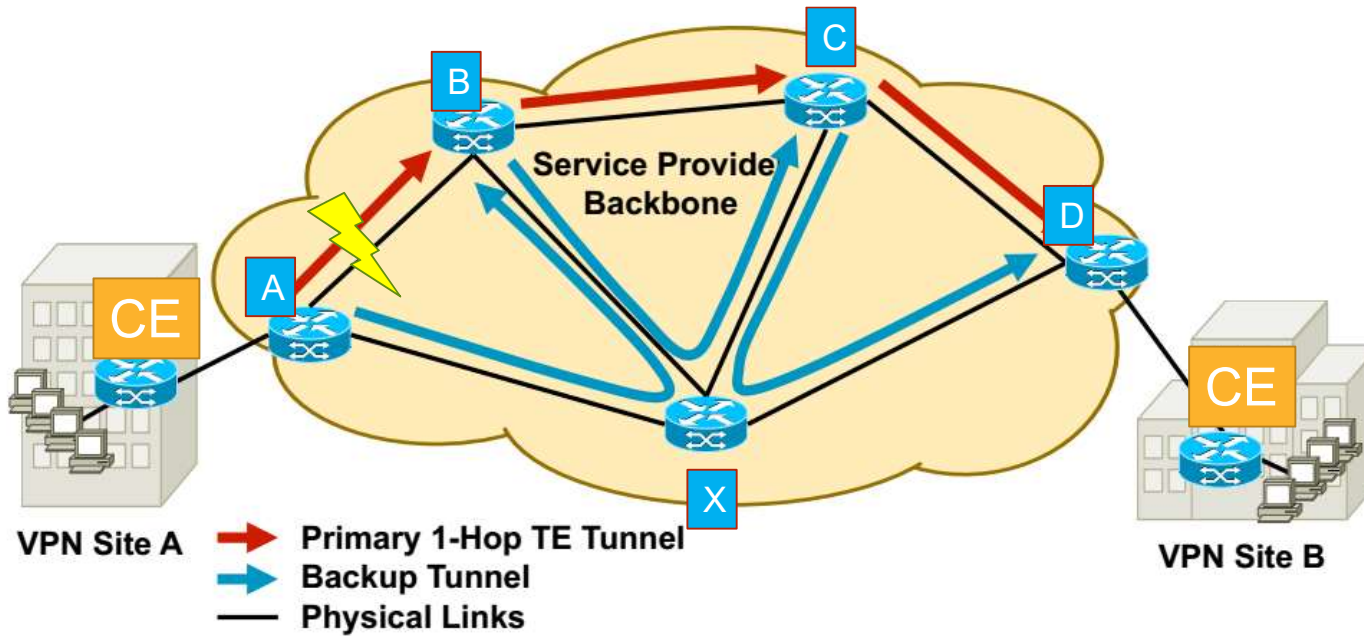


SEBELUM



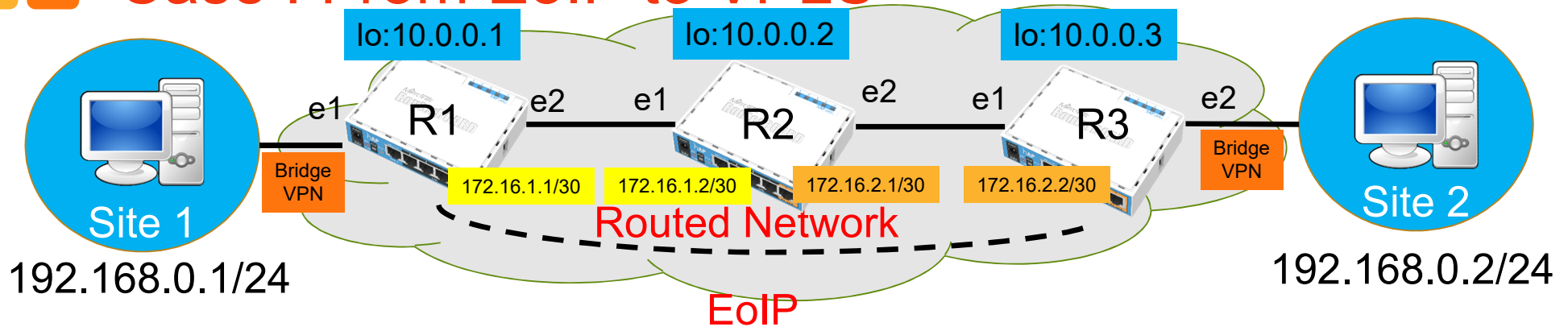
SESUDAH

MPLS TE : Bandwidth Protection



- Primary Tunnel : A -> B -> C -> D
- Secondary Tunnel : A -> X -> B -> C -> D

Case : From EoIP to VPLS



- **Kasus** : Dari contoh jaringan diatas, sebuah jaringan routing untuk interkoneksi antar Router R1, R2 dan R3
- EoIP tunnel menjadi solusi untuk menghubungkan Site 1 dan Site 2 secara Layer 2 dengan EoIP Tunnel antar R1 dan R3
- **Solusi** : Akan kita migrasi menjadi MPLS Network, sehingga bias diterapkan L2 VPN dengan VPLS



MPLS LDP

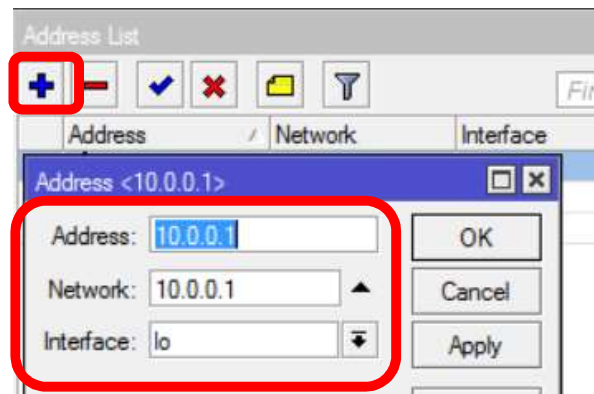
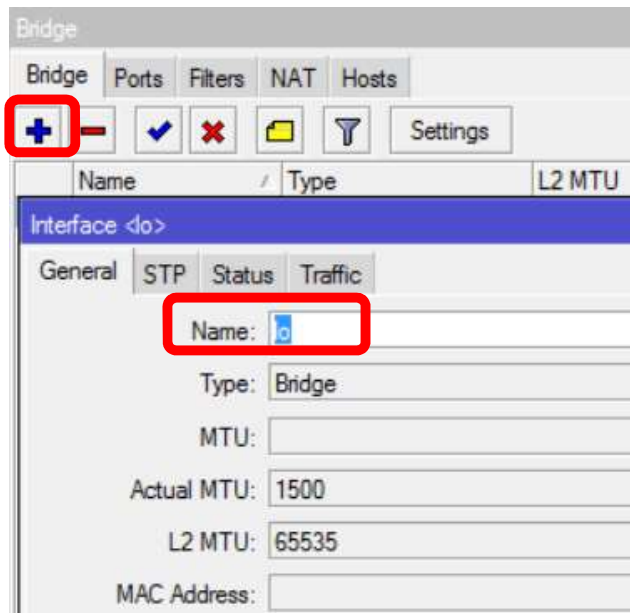
- Label dibuat dan distribusikan secara otomatis oleh Label Distribution Protocol (LDP)
- LDP requirements :
 - Semua Network harus terkoneksi dengan baik secara Routing
 - IP Loopback (rekomendasi)
 - Seluruh Router pada MPLS Network harus menjalankan MPLS.



MPLS Configuration Step

- Pasang IP Address sesuai Diagram
- Tambahkan Interface Bridge sebagai Loopback Interface
- Pasang IP Loopback pada interface Bridge Loopback
- Aktifkan OSPF :
 - Gunakan Area : Backbone
 - Advertise Network Local
 - Advertise IP loopback
- Aktifkan LDP
- Isi LSR-ID dan Transport-Address dengan IP loopback
- Tambahkan LDP Interface (yg terhubung dengan Router MPLS)
- Cek Forwarding Table, Local Binding dan Remote Bindings
- Test Traceroute

Create Loopback



Configure OSPF

OSPF

Interfaces Instances Networks Areas Area Ranges

+ - ✓ ✗ 📄 🗑️

Network	Area
10.0.0.1	backbone
172.16.1.0/30	backbone

OSPF Network <10.0.0.1>

Network: 10.0.0.1

Area: backbone

OK Cancel Apply Disable Comment Copy Remove

enabled

OSPF Network <172.16.1.0/30>

Network: 172.16.1.0/30

Area: backbone

OK Cancel Apply Disable Comment Copy Remove

enabled

Configure LDP

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table

+ - ✓ ✕ [Filter Icon] MPLS Settings LDP Settings

Interface	Hello Interval	Hold Time	Transport Address	Accept Dy...
				yes

LDP Settings

Enabled

LSR ID: 10.0.0.1

Transport Address: 10.0.0.1

Path Vector Limit: 255

Hop Limit: 255

Loop Detect

Use Explicit Null

Distribute For Default Route

OK Cancel Apply

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table MPL

+ - ✓ ✕ [Filter Icon] MPLS Settings LDP Settings

Interface	Hello Interval	Hold Time	Transport Address	Accept Dy...
				yes

MPLS Interface <ether2>

Interface: ether2

Hello Interval: 00:00:05

Hold Time: 00:00:15

Transport Address:

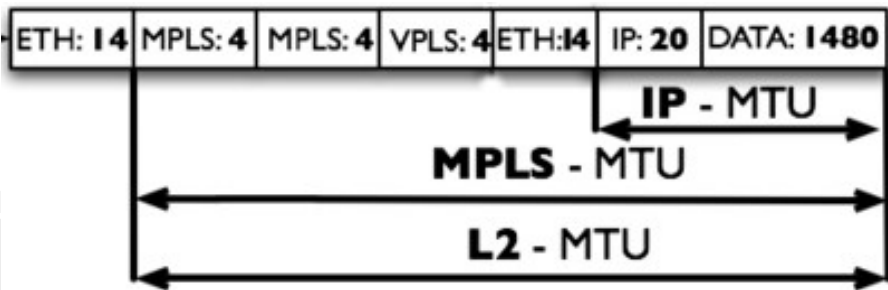
Accept Dynamic Neighbors

OK Cancel Apply Disable Comment Copy Remove

enabled

L2MTU

RouterBoard	
RB411 series	ether1:1526
RB433 series	ether1:1526; ether2-ether3:1522
RB450	ether1:1526; ether2-ether5:1522
RB493 series	ether1:1526; ether2-ether9:1522
RB411GL	ether1:1520
RB433GL	ether1-ether3:1520
RB435G	ether1-ether3:1520
RB450G	ether1-ether5:1520
RB493G	ether1-ether9:1520



VPLS – MPLS
L2MTU: 1526

Test Traceroute MPLS & Check MPLS

Traceroute (Running)

Traceroute To: 10.0.0.3

Packet Size: 56

Timeout: 1000 ms

Protocol: icmp

Port: 33434

Use DNS

Count: [dropdown]

Max Hops: [dropdown]

Src. Address: [dropdown]

Interface: [dropdown]

DSCP: [dropdown]

Routing Table: [dropdown]

Hop	/	Host	Loss	Sent	Last	Avg.	Best	Worst	Std. Dev.	History	Status
1		172.16.1.2	0.0%	298	0.3ms	0.3	0.3	1.0	0.1		
2		10.0.0.3	0.0%	298	0.2ms	0.2	0.2	1.3	0.1		<MPLS:L=19,E=0>

MPLS SUKSES !!

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table MPLS Interfa

	Dst. Address	/	Label	Nexthop	Peer	Path
D	10.0.0.1		17	0.0.0.0	10.0.0.2:0	empty
DA	10.0.0.2		impl-null	172.16.1.2	10.0.0.2:0	empty
DA	10.0.0.3		19	172.16.1.2	10.0.0.2:0	empty
D	172.16.1.0/30		impl-null	0.0.0.0	10.0.0.2:0	empty
DA	172.16.2.0/30		impl-null	172.16.1.2	10.0.0.2:0	empty
DA	172.16.4.0/30		18	172.16.1.2	10.0.0.2:0	empty

MPLS

LDP Interface LDP Neighbor Accept Filter Advertise Filter Forwarding Table MPLS Interf

In Label	/	Out Labels	Interface	Nexthop	Destination
expl-null					
16			ether2	172.16.1.2	172.16.2.0/30
17			ether2	172.16.1.2	10.0.0.2
18	18		ether2	172.16.1.2	172.16.4.0/30
19	19		ether2	172.16.1.2	10.0.0.3



VPLS Configuration Step

- Create Interface VPLS
- Create Bridge Port
- Masukkan Interface VPLS dan Ether yg ke arah site dalam Bridge Port
- Test Ping antar Site

Create Interface VPLS

VPLS

VPLS BGP VPLS Cisco BGP VPLS

Interface <R1toR3>

General Status Traffic

Name: R1toR3

Type: VPLS

MTU: 1500

Actual MTU: 1500

L2 MTU: 1500

MAC Address: 02:9A:62:C6:B2:3C

ARP: enabled

ARP Timeout:

Remote Peer: 10.0.0.3

VPLS ID: 1:1

Cisco Style

Cisco Style ID: 0

Advertised L2MTU: 1500

PW Type: tagged ethernet raw ethernet

OK Cancel Apply Disable Comment Copy Remove Torch

Isikan dengan IP Loopback Remote Peer

VPLS ID / Tunnel ID harus sama dengan Remote

Create Bridge VPN dan masukan VPLS + Ether

Bridge

Bridge Ports Filters NAT Hosts

+ - [] [] [] [] [] Settings

Name	Type	L2 MTU	Tx
------	------	--------	----

New Interface

General STP Status Traffic

Name: R1toR3

Type: Bridge

MTU: []

Actual MTU: []

L2 MTU: []

MAC Address: []

ARP: enabled

ARP Timeout: []

Admin. MAC Address: []

OK Cancel Apply Disable Comment Copy Remove Torch

Bridge

Bridge Ports Filters NAT Hosts

+ - [] [] [] [] []

Interface	Bridge	Priority (h...	Path Cost	Horizon	Role	Root Pat...
R1toR3	VPN	80	10		root port	10
ether1	VPN	80	10		designated port	

Test Ping

Traceroute (Running)

Traceroute To: 192.168.0.2

Packet Size: 56

Timeout: 1000

Protocol: icmp

Port: 33434

Use DNS

Count:

Max Hops:

Src. Address:

Interface:

DSCP:

Routing Table:

Hop	Host	Loss	Sent	Last	Avg	Best	Worst	Std. Dev.	History	Status
1	192.168.0.2	0.0%	8	0.5ms	0.5	0.5	0.5	0.0		

VPLS SUKSES !!



From EoIP to VPLS : Configuration

- **Add IP Address and Loopback**

#on R1

```
/interface bridge
add name=lo
/ip address
add address=10.0.0.1 interface=lo network=10.0.0.1
add address=172.16.1.1/30 interface=ether2 network=172.16.1.0
```

#on R2

```
/interface bridge
add name=lo
/ip address
add address=10.0.0.2 interface=lo network=10.0.0.2
add address=172.16.1.2/30 interface=ether1 network=172.16.1.0
add address=172.16.2.1/30 interface=ether2 network=172.16.2.0
```

#on R3

```
/interface bridge
add name=lo
/ip address
add address=10.0.0.3 interface=lo network=10.0.0.3
add address=172.16.2.2/30 interface=ether1 network=172.16.2.0
```



From EoIP to VPLS : Configuration

- **Enable OSPF Routing Protocol**

#on R1

```
/routing ospf network  
add area=backbone network=10.0.0.1/32  
add area=backbone network=172.16.1
```

#on R2

```
/routing ospf network  
add area=backbone network=10.0.0.2/32  
add area=backbone network=172.16.1.0/30  
add area=backbone network=172.16.2.0/30
```

#on R3

```
/routing ospf network  
add area=backbone network=10.0.0.3/32  
add area=backbone network=172.16.2.0/30
```



From EoIP to VPLS : Configuration

- **Enable LDP**

#on R1

```
/mpls ldp
    set enabled=yes lsr-id=10.0.0.1 \
    transport-address=10.0.0.1
/mpls ldp interface
    add interface=ether2
```

#on R2

```
/mpls ldp
    set enabled=yes lsr-id=10.0.0.2 \
    transport-address=10.0.0.2
/mpls ldp interface
    add interface=ether1
    add interface=ether2
```

#on R3

```
/mpls ldp
    set enabled=yes lsr-id=10.0.0.3 \
    transport-address=10.0.0.3
/mpls ldp interface
    add interface=ether1
```



From EoIP to VPLS : Configuration

- **Configure VPLS**

#on R1

```
/interface vpls add name=R1toR3 remote-peer=10.0.0.3 \  
    vpls-id=1:1  
/interface bridge port add bridge=vpn interface=R1toR3
```

#on R3

```
/interface vpls add name=R3toR1 remote-peer=10.0.0.1 \  
    vpls-id=1:1  
/interface bridge port add bridge=vpn interface=R3toR1
```



From EoIP to VPLS : Configuration

- **Create Bridge & Insert VPLS Port + Ether**

#on R1

```
/interface bridge port add bridge=vpn interface=R1toR3  
/interface bridge port  
add bridge=vpn interface=ether1  
add bridge=vpn interface=R1toR3
```

#on R3

```
/interface bridge port add bridge=vpn interface=R3toR1  
/interface bridge port  
add bridge=vpn interface=ether2  
add bridge=vpn interface=R3toR1
```

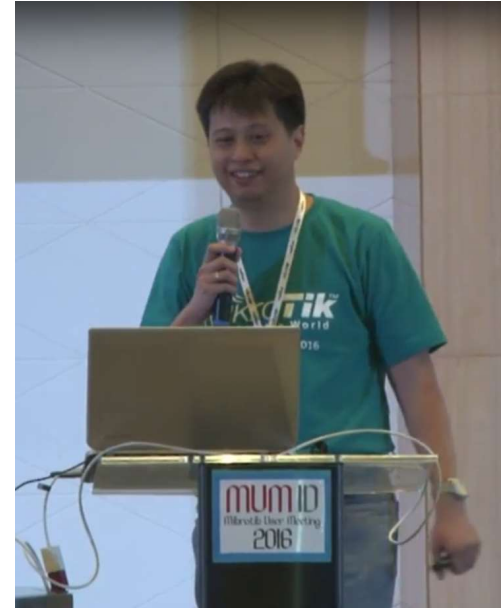



SUMMARY

- MPLS meningkatkan :
 - Performance jaringan
 - Efisiensi dalam jaringan
 - Skalabilitas dalam jaringan
 - Mempermudah konfigurasi dan manage Jaringan
 - Menambah jumlah kemungkinan solusi VPN
- MPLS dapat melakukan Bandwidth Optimizing
- MPLS dapat melakukan Redundant dan Fail Over Link



THANK YOU



Irvan Adrian K - Irvan@grahamedia.net.id

Jakarta

Mikrotik User Meeting – Indonesia 2016